2008

The 3 omegas - not as easy as 1, 2, 3

Barbara Meyer
University of Wollongong, bmeyer@uow.edu.au

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Abstract

A fatty acid database developed by Mann & others (2003) was used to determine the Australian intakes and food sources of long chain n-3 polyunsaturated fatty acids from the 1995 National Nutrition Survey (NNS). Average daily intakes of eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA) and docosahexaenoic acid (DHA) were 0.056, 0.026, and 0.106 g/d respectively (Meyer & others 2003). Subsequent inclusion of newly available data on meats into the fatty acid database and re-analysis of the NNS resulted in higher calculated intake of DPA (0.071 g/d) because DPA content of meats was previously underestimated (Howe & others 2006). However, fish/seafood is still the main contributor to LC n-3 PUFA intakes. The food industry also now provides foods fortified with LC n-3 PUFA. Hence the fatty acid database warrants continual updating.

Keywords

omegas, not, easy

Disciplines

Arts and Humanities | Life Sciences | Medicine and Health Sciences | Social and Behavioral Sciences

Publication Details

Meyer, B. J. 2008, "The 3 omegas - not as easy as 1, 2, 3", Food Australia, vol. 60, no. 1, 2, pp. 41-43.

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B. J. Meyer

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Health authorities advocate a healthy diet which includes a reduction in saturated fat and increased consumption of unsaturated fats, especially omega-3 polyunsaturated fatty acids (n-3 PUFA). The n-3 PUFA consist predominantly of alpha-linolenic acid (LNA), eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA) and docosahexaenoic acid (DHA) and most health benefits have been attributed to the latter three, namely the long chain n-3 PUFA (LC n-3 PUFA).

Humans are able to synthesise the LC n-3 PUFA from LNA, although the physiological relevance of such a small proportion of conversion (estimated at 0.05–4.0%) is questionable (Burdge 2004). Hence direct consumption of the LC n-3 PUFA may be more beneficial than relying on LNA intakes and their subsequent conversion to the LC n-3 PUFA. However, in order to be able to determine the PUFA intakes of a population, for example, a nutrient database containing accurate data on nutrients, especially LC n-3 PUFA, is vital.

In the early 1990s, teaching and research in the area of n-3 PUFA were then, and still are, exciting. However, the lack of detailed nutrient databases on the n-3 PUFA content of foods was noticeable. Hence there was a great need to update and establish a fatty acid database which contained the detailed information on all fatty acids, including the LC n-3 PUFA.

Methods

In 1995, all existing published data on n-3 PUFA content of foods were collated and published in *food Australia* in 1999 (Meyer & others 1999). The collated data were used to determine the intakes and food sources of n-6 and n-3 PUFA of adult Australians living in the Illawarra region of NSW as described by Ollis & others (1999) using three-day weighed food records calculated using Diet 1 (version 4, Xyris Software) for most nutrients. Food composition tables (from Meyer & others 1999) were used to determine nutrient levels in fish, meat, nuts, oils, egg and dairy; *Composition of Foods Australia* (Cashel & others 1989) to determine bread, cereals, snacks, desserts and take away foods; and *The Composition of Foods* (Paul & others 1980) to determine fruit and vegetables, as described by Ollis & others (1999).

As a result of the limited data on LC n-3 PUFA in these existing databases, researchers recognised the need to develop a comprehensive fatty acid database. The process of this fatty acid database development is described in detail by Mann & others (2003) from RMIT in Melbourne. The RMIT fatty acid database was constructed in a Microsoft Excel™ spreadsheet using the NUTTAB95 fatty acid file provided by Australia New Zealand Food Authority (ANZFA 1999), in g/100 g edible portion and to two decimal places (1116 foods). Prior to this, the NUTTAB95 database only provided fatty acid data to one decimal place. LC n-3 PUFA are present in very small amounts in foods, eg 0.03 g/100 g edible portion, and these values were rounded down to zero when using one decimal place only. Therefore it was vital to obtain the fatty acid data to two decimal places. Some of the foods (449 items) were excluded due to obviously erroneous data, eg egg data that lacked arachidonic acid, when egg yolk contains typically 400 mg/100 g (Mann & others 1995). Data for foods that were analysed for fatty acids using gas chromatography were obtained from reputable sources in Australia and New Zealand and from various other research laboratories. The data were often obtained as % of total fatty acids and if the total lipid content was reported and a relevant lipid conversion factor was available (Cashel & others 1989), this allowed us to calculate the fatty acid concentrations as mg/100 g. In total, 1044 foods were included in the RMIT fatty acid database (Mann & others 2003). Using this new fatty acid database the Australian intakes and food sources of n-6 and n-3 PUFA from the 1995 National Nutrition Survey (McLennan & Podger 1997) were determined and the outcomes published in Meyer & others (2003).

However, since then, an additional 350 newly analysed lean and fatty portions of red meat have been incorporated into the fatty acid database as described by Howe & others (2006). The Australian intakes and food sources of n-3 PUFA from the 1995 National Nutrition Survey were subsequently re-assessed using this newly updated fatty acid database to provide better estimates of LC n-3 PUFA, particularly in relation to meat sources.

Associate Professor Barbara Meyer is with the School of Health Sciences, Smart Foods Centre and the Metabolic Research Centre University of Wollongong, NSW; email: bmeyer@uow.edu.au.

Results

Table 1 shows the collated published PUFA results for a few examples of fish. There is great variation in these results. For example, barramundi total fat content ranges from 600 to 2100 mg/100 g edible portion which is a 3.5 fold difference. Barramundi EPA, DPA and DHA content also vary greatly with a 6-fold difference between the data. Australian salmon (*Arripis trutta*) is much leaner than Atlantic salmon (*Salmo salar*) which is 4.7-fold higher in total fat, and there is a 3.2-fold difference in EPA, DPA and DHA levels (Table 1). There are also differences in the processed fish products with an approximate 2-fold difference in total fat and EPA, DPA and DHA levels when comparing different brands.

The results of the development of a fatty acid database containing approximately 1100 foods have been published previously (Mann & others 2003). Only analytical data, and not estimated or derived data are expressed in g/100 g of edible portion to two decimal places. The fatty acid database is available in the dietary analysis software platform, Foodworks (Xyris 2002).

Table 2 shows the estimated Australian intakes of LC n-3 PUFA over time as described in the methods section. The first two estimates, namely the Illawarra region of NSW intakes (Ollis & others 1999) and the 1995 National Nutrition Survey intakes (Meyer & others 2003) are comparable. The third estimate of LC n-3 PUFA (Howe & others 2006) is higher than the original two estimates and this is reflected primarily in higher DPA intakes.

Discussion

A fatty acid database which includes the LC n-3 PUFA has been established, despite various limitations including the great variation in LC n-3 PUFA data, especially in fish products (Table 1). This great variation in data could be due to a number of factors, eg differences in environments, different food sources and different phases of feeding when the fish were caught. Furthermore, whether the fish samples included the skin and the fat depots under the skin makes a huge difference in the total fat content as well as the different types of fat. The processing of fish for canning could also influence the total and LC n-3 PUFA content of fish products (Meyer & others 1999). NUTTAB95 (ANZFA 1999) and Nichols (1998) provided the information regarding the most commonly consumed fish and seafood in Australia for inclusion in the fatty acid database (Mann & others 2003).

The fatty acid database within the dietary analysis software platform Foodworks (Xyris 2002), as a stand alone database for analyses of fatty acid composition of foods, has the limitation that to analyse dietary intake data

Table 1. Examples of differences in published lipid data on fish.

Fish	Fat (mg/100 g)	Fatty acids			
		Total n-6 (mg/100 g)	18:3n-3 (mg/100 g)	20:5n-3, 22:5n-3, 22:6n-3 (mg/100 g)	Total n-3 PUFA (mg/100 g)
Barramundi [1]	800	131	14	84	99
Barramundi [1]	600	99	4	122	127
Barramundi [1]	2100	82	35	52	555
Salmon (Atlantic*) [2]	7100	592	108	1836	2131
Salmon (Australian**) [2]	1500	48	5	615	626
Salmon (Australian**) [1]	1800	179	13	571	584
Canned Salmon-red* (Farmland) [3]	6400	93	35	858	960
Canned Salmon-red* (John West) [3]	12300	191	104	1963	2231
Canned Salmon-red* (Paramount) [3]	10400	178	89	1740	2133

[1] Brown & others (1989), [2] Sinclair & others (1992), [3] Sinclair personal communication, * *Salmo salar*, ** *Arripis trutta*

Table 2. Comparison of LC n-3 PUFA (mg/d) intakes over time using various databases.

Reference	Database used	EPA	DPA	DHA	Total LC n-3 PUFA
Ollis & others (1999)	Various databases calculated manually	ns*	ns	ns	180
Meyer & others (2003)	Fatty acid database (Mann & others 2003)	56	26	106	189
Howe & others (2006)	Updated fatty acid database (Howe & others 2006)	75	71	100	246

*ns - not specified

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double entry is necessary in order to obtain the full complement of nutrient analyses, including energy, macronutrient and micronutrient analysis as well as the detailed fatty acid analysis. To rectify this, the ultimate goal is to incorporate the fatty acid database into the main Australian nutrient database. The difficulty with incorporating the fatty acid data is that there is no compositional information about these foods other than fatty acids. There is no information regarding total weight, moisture content, total energy or any of the other macronutrients and micronutrients. Hence the double entry of foods into the nutrient analysis database and then again into the fatty acid database is the only option available at the moment.

The most common use of nutrition databases is for the purpose of nutrient analysis of food intakes. However, if erroneous data or 'old data' were used in the database, the results of such analysis can be misleading. For example, the 1995 National Nutrition Survey had to be analysed twice for estimating fatty acid intakes: once using the fatty acid database (Mann & others 2003) and the second time, using the updated data on meat (Meyer & others 2003, Howe & others 2006), respectively. As seen in Table 2, utilising 'old data' can deliver different results. There was a 2.76-fold difference in the estimated DPA intakes of adult Australians and primarily due to underestimates of DPA in meats. It was originally thought that meat contributed approximately 20% of intakes of LC n-3 PUFA (Meyer & others 2003) whereas reanalysis using the updated database on meats, suggests that this contribution is as high as 43% of LC n-3 PUFA intakes. This is not to say that meat is a high source of LC n-3 PUFA, but Australians consume six times more meat (164 g/day) than fish on average (28 g/day) (Ollis & others 1999). Therefore meat makes a high contribution to our total LC n-3 PUFA intakes, even though fish/seafood is the richest food source of LC n-3 PUFA. This example highlights the need to continually update the database as new analytical data becomes available. Furthermore, there has been a marked swing from consuming wild caught fish to farmed fish which tend to have different fatty acid profiles, therefore these databases not only need to incorporate data improvements but should also reflect dominant eating habits in the population under study.

Most Australians do not consume fish/seafood regularly if at all, but the food industry has been proactive in developing foods fortified with LC n-3 PUFA, including fortified breads, muffins, margarines, milks and eggs, and so on. With the introduction of these fortified foods, the fatty acid database will need to be continually updated. Another way and perhaps easier way to increase the consumption of LC n-3 PUFA is dietary supplements. There are several brands available in the marketplace, including double strength capsules as well as fruit flavoured ones for children.

In summary, firstly there has been progress on the development of a fatty acid database for Australian foods; however, it has its limitations in the requirement for continuous updating and, as a stand alone database there is a requirement for double entry of dietary intake data. Secondly, users of nutrient databases need to understand the sources and quality of published data, whether they are analytical data or calculated/derived data, otherwise results of dietary intake analysis can be misleading.

Acknowledgments

The author acknowledges the importance of the valuable contributions of the greater research team over the years: Effie Tsivis, Tenille Ollis, Paul Percival, Greg Milligan, Peter Howe, Neil Mann, Andrew Sinclair, Janine Lewis, Sally Record and Katrine Baghurst. Funding provided by Unilever Australia, Meadow Lea Foods and Grains Research Development Corporation is also gratefully acknowledged.

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